UNIVERSITY

OF

NORTH CAROLINA.

ORDER OF EXERCISES

FOR

COMMENCEMENT,

I. JUNE, MDCCCLIV.

RALEIGH:

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1854.

Illustrissimo DAVIDI S. REID, Armigero,

CAROLINÆ BOREALIS REIPUBLICÆ,

GUBERNATORI,

Honorando DAVIDI L. SWAIN, Armigero, LL. D.,

FACULTATIS PRÆSIDI;

Omnibusque SENATUS Academici Sociis:

Universis denique humanitatis cultoribus;

EXERCITATIONES HASCE

Juvenes hodie primi gradus in Artibus honorem petentes,

Gulielmus-Lee Alexander
Junius-Franklin Allison
Joannes-Burr Andrews
Gulielmus Badham, junior
Ricardus-Henricus Battle
Josephus-Masters Bell
Edvardus Bradford, junior
Ricardus Bradford
Daniel-Iverson Brooks
Joannes-Henricus Bullock
Gulielmus-Henricus Bunn,
Joannes-Shemwell Chambers
Joannes-Probert Cobb
Needham-Bryan Cobb
Elnathan-Hayne Davis
Thomas-Colgate Dennis
Josephus-Adolphus Engelhard
Edvardus-Livingston Faison
Joannes-Marion Gallaway
Albertus-Kimbrough Graham
Joannes-Williams Graves
Joannes-Gray-Blount Grimes
Joannes-Hampden Hill
Delano-Whiting Husted
Samuel-Spencer Jackson, junior
Jacobus-Gulielmus Jacobs
Robertus-Bruce Johnston
Josephus-Pickett Jones
Gulielmus-Leak Ledbetter
Ivey-Foreman Lewis
Gulielmus-Stevens Long
Joannes-Campbell McKethan
Leonidas-Joannes Merritt
Jacobus-Archibaldus Montgomery,
Jacobus-Cameron Moore
Joannes-Murdock Morrison
Joannes Neal
Gulielmus-Carolus Nichols
Theophilus Perry
Carolus W. Phifer
Oscar-Ripley Rand
David-Gillespie Robeson
Joannes-Kirkland Ruffin
Joannes-Gulielmus Sandford
Ricardus-Baker Saunders
Gulielmus-Lawrence Saunders
Rufus Scott
Gulielmus-Lafayette Scott
Joannes-Duncan Shaw
Robertus-Moderwell Sloan, junior
Gulielmus-Henricus Spencer
Gulielmus Thompson
Gulielmus-Henricus Thomson
Enochus-Gaspar Vann
Josua-Cochran Walker
Gulielmus-Robards Wetmore
Bryan Whitfield
Theodorus Whitfield
Jacobus-Allan Wright
Josephus Hill Wright

REVERENTER DEDICANT.

FORENOON.

I. Sacred Music.

O God, our Fathers' God, whose care,
With blessings fills the circling year,
Rememb'ring Thee in all our ways,
We bring our Annual song of praise.

We bless thy name, Almighty God,
Who giv'st us here a sure abode,
For all the favor thou hast shown,
The State and Age we call our own.

Here Freedom spreads her banner wide;
Here Learning and Religion guide,
By Heavenly Truth's unfading ray,
Our youth in Wisdom's narrow way.

From Thee unnumber'd blessings flow,—
Life, health and strength Thy hands bestow;
And every good Thy creatures share
Springs from Thy providential care.

From Thee proceed our social ties,
And all the bliss that they comprise;
On Thy support the nations stand,
Obedient to Thy high command.

Eternal Source of every joy!
Well may Thy praise our lips employ,
And all our powers unite to bless
The Lord, our Strength and Righteousness.

II. Prayer.

III. Latin Salutatory.

WILLIAM BADHAM, Jr. *Edenton.*

MUSIC.

IV. A greeting to all our friends.

JOHN DUNCAN SHAW, *Richmond County.*

MUSIC.

V. Science in the Bible.

WILLIAM HENRY SPENCER, *Hyde Co.*

MUSIC.

VI. Young America.

JOHN MARION GALLAWAY, *Rockingham Co.*

MUSIC.

VII. Why love the Turk and hate the Russian?

ENOCH JASPER VANN, *Florida.*

MUSIC.

VIII. The scale of Being.

SAMUEL SPENCER JACKSON, Jr. *Pittsboro'.*

MUSIC.

IX. Distribution of the Bible.

THEODORE WHITFIELD, *Mississippi.*

MUSIC.

X. The Future.

JOSEPH HILL WRIGHT, *Wilmington.*

MUSIC.

XI. Denominational Education.

LEONIDAS JOHN MERRITT, *Chatham Co.*

MUSIC.

XII. Growth of English Liberty.

OSCAR RIPLEY RAND, *Wake Co.*

MUSIC.

XIII. The Farming interest in North Carolina.
ROBERT BRUCE JOHNSTON, *Waynesvllei.*

XIV. French Oration—Lafayette.
WILLIAM ROBARDS WETMORE, *Fayetteville.*

AFTERNOON.

I. Greek Oration—'To Prepon.'
JOHN WILLIAMS GRAVES, *Caswell Co.*

MUSIC.

II. Practical benefits conferred by Astronomy.
RICHARD HENRY BATTLE, *Chapel Hill.*

MUSIC.

III. Legislative aid to the University.
WILLIAM LEE ALEXANDER, *McDowell Co.*

MUSIC.

IV. Where are we?
JOSEPH ADOLPHUS ENGELHARD, *Jackson, Miss.*

MUSIC.

V. Annual Report.

VI. Degrees conferred.

VII. The Valedictory.

WILLIAM LAFAYETTE SCOTT, *Guilford Co.*

VIII. Sacred Music.

PSALM CXVII.

From all that dwell below the skies,
Let the CREATOR'S praise arise;
JEHOVAH'S glorious name be sung,
Through every land, by every tongue.

Eternal are Thy mercies, LORD,
And truth eternal is Thy word;
Thy praise shall sound from shore to shore,
Till suns shall rise and set no more.

Praise GOD from whom all blessings flow,—
Praise Him all creatures here below:
Praise Him above, y'angelic host,
Praise Father, Son, and Holy Ghost.

IX. Benediction.

Habita in COMITIIS UNIVERSITATIS CAROLINÆ BOREALIS,

Die Junii Primo, Anno Salutis, MDCCCLIV.

RERUMQUE PUBLICARUM FŒDERARATUM AMERICÆ SUMMÆ POTESTATIS LXXVIII.

NATURAL HISTORY.

Natural History ascertains the different substances that exist naturally, either within or upon the surface of the earth, and classifies and describes them by their properties or characters.

Considered with reference to this department of knowledge, natural substances arrange themselves into two great classes.

1. *Organized Beings;* comprising the two subordinate divisions of *plants* and *animals.* They are so called, because they are constituted or made up of a collection of organs or instruments, destined to the preservation and maintenance of the life and well-being of the individual, and the perpetuation of the race. They have all been formed by the agency of the principle of life, controlling other forces originally and naturally inherent in the elements of which they are composed.

2. *Unorganized matter;* as seen in rocks and stones. These have been produced by powers inherent in the particles of which they are composed, aided, in some cases, by heat, mechanical pressure, and other foreign forces; but without the agency of life.

Upon these distinctions is founded the separation of the substances occupying the surface and outer crust of the earth into the three great kingdoms of Nature :—the Animal, Vegetable, and Mineral—the objects of the sciences of Zoology, Botany, and Mineralogy.

When an individual body or substance belonging to one of these kingdoms is presented to the Naturalist, or person engaged in the study of Natural History, his first object is to *classify it*—to assign the animal, vegetable, or mineral species to which it belongs, and *the name therefore which it bears in the scientific books.* If it be new, he forms it into a new species, and *describes* it so that other Naturalists will be able to recognise it should it fall in their way. It is to be remarked, however, that amongst organized bodies, it is the whole system of organization, —the whole plant or animal, and not a branch or limb: in the mineral kingdom, it is the smallest fragment: that constitutes an individual substance or object of Natural History.

It is our practice to make one of the kingdoms of nature (the Mineral) an object of attention for a considerable time, whilst we

devote but a single lecture to each of the others; and these for the purpose of communicating a knowledge of the *methods* of Natural History, as much as with reference to the sciences of Botany and Zoology themselves. It will, for several reasons, be most convenient to commence with the Vegetable kingdom.

BOTANY.

Object of the Science. Principally to enable us to determine the particular *species* to which a given vegetable belongs.

Certain plants bear a very intimate resemblance to each other, in regard to their aspect, size, duration, time of maturity, the form of their leaves, their action upon the organs of taste, and other sensible characters; the diversities that obtain between different individuals being accidental, and depending on foreign causes. Example—two different stalks of wheat or corn. If a seed from either of these resembling vegetables be covered to a moderate depth with earth, a new plant *of the same kind* will rise from it. The vegetables between which this intimate agreement obtains are said to belong to the same species, and are supposed to derive their existence from a common origin. Jussieu's definition of a species—"A perennial succession of similar individuals, deriving their origin from successive generation."

In other cases there are observed resemblances, with points of difference; which, though not considerable, are *constant*, and continue when new plants are raised from the seed. These vegetables, nearly related but different, are supposed to be sprung from different original stocks. They are included in the same genus, but are referred to different species.

It is the object of the science of Botany to make us acquainted with the Vegetable kingdom, and enable us to determine, by comparing it with its description, contained in a Flora, the species to which a particular plant belongs.

Of the Classification and Terminology. The young botanist has first to apply himself to the acquisition of the system of classification and the terminology; the former of which is rendered necessary by the number of the vegetable species, those that are known amounting already to more than 50,000, and daily increasing. If a person have a series of volumes containing a description of all these species, or even of the plants in his own neighbourhood amounting to one or two thousand, it must create an intolerable weariness and disgust to be obliged to read carefully through a whole volume, and much more, a number of volumes, for the purpose of ascertaining the name of a plant he has just found. *It was to prevent the necessity of this, that a system of classification was originally devised and is now employed.*

The first attempts to classify vegetables were ill directed and

unsuccessful. They were arranged under the three heads; of trees, shrubs, and herbs. Defects of this system. The classes are neither well defined and distinct, nor sufficiently numerous. It is not possible to say, in regard to some vegetables, whether they are trees, shrubs, or herbs. Other schemes of classification, some of them modifications of that just noticed, and others more or less new, were from time to time proposed; but none of them satisfied the Naturalists who were making the vegetable world the object of their study, or enjoyed more than a temporary reputation, until Linnæus published his Fundamenta Botanica in 1735.

Qualities of a good system of classification.

1. It must be founded on diversities, presented by some part or parts, common to all, or nearly all, the objects we would classify.

2. The part or parts on which the classification is founded, must be sufficiently distinct, and not subject to vary.

3. The classes formed must be neither too numerous nor too few.

We cannot, therefore, classify vegetables by their stems or their leaves; because these parts are wanting in some, subject to vary in others, and would not furnish a convenient number of classes.

The only part that is necessarily common to all plants, and fitted in every respect to our purpose, is the *fructification;* meaning by this the whole apparatus employed in producing and perfecting the seed. With this, whatever else it may want, every plant must be provided; since upon its presence the continued existence of that particular species of plant must ordinarily depend. It had been employed before the time of Linnæus; but this great naturalist fully established, and laid at the foundation of his system, one important fact, which, though not altogether unknown, had been much neglected by preceding Botanists—*that something analogous to the difference of sex in animals obtains in the vegetable kingdom.* It may seem remarkable, that this truth should have remained so long in obscurity, and mankind have contented themselves with looking in stupid wonder upon the little apparatus that lies in the bosom of every flower, without troubling themselves to inquire whether it is of any use in the economy of the plant.

It may be stated, as some apology for their ignorance, that most flowers are hermaphrodite; containing both the male and female parts in close proximity. In a few cases, where the sexes are on different trees, the nature of their economy was in some measure understood even by the ancients. Thus we are informed by Herodotus, that in the planting of the Palm groves, in the vicinity of Babylon, care was taken that the greater part of the soil should be occupied by such stocks as were known to produce female flowers and fruit. Here and there, at consider-

able intervals, they introduced a male tree; which, though yielding nothing itself, rendered those in its neighbourhood productive; and the Babylonians were in the practice of aiding the operations of nature, by collecting branches covered with the male, and attaching them to trees bearing female flowers. Account of a similar experiment with a female palm tree, in the garden of the Royal Academy of Berlin, fecundated by means of a branch brought from Leipsic, ninety miles distant.

The common Lombardy Poplar is another example of this (diœcious) class of vegetables. It is a native of the shores of the Mediterranean, and the tree into which the sisters of Phaeton were changed, after having long bewailed his fate on the banks of the Po: and it may be remarked, that this fable of the poets acquires a new interest when we have the figure of this tree before us. There is no other that is so well entitled to stand as the representative of female grace and beauty. It is a male stock that we have in this country. To the same class belong, though less strictly, the persimmon, and the different species of N. American grapes.

In the Maize or Indian corn, the male and female parts are at a distance from each other on the same plant; the former in the top or tassel, and the latter in the silk and ear. If the tassels be removed throughout a whole field of corn, just before the period of inflorescence, the production of a crop will be prevented as effectually as by tearing it up by the roots.

Every plant, then, must contain a system of male or female organs, and, a very few cases excepted, it contains both; and if these present (as they do) a considerable diversity in their number, form, and position, they will furnish a foundation for a good system of classification. The number of the stamina varies in different plants from one to more than an hundred. In their length and mode of insertion, there is a similar diversity, so also of the styles.

Classes. Linnæus selected *the stamina, or male part of the flower*, to furnish the first grand divisions of his system, distributing the Vegetable world into 24 great classes.

1. The first ten classes comprise such plants as have hermaphrodite flowers, with from one to ten equal or *irregularly* unequal and unconnected stamina. It is from the number of these that they are determined and named. Thus, the class Monandria includes all plants that have only one stamen; the class Diandria, such as have two stamina, &c.

2. The eleventh class includes such as have from 12 to 19 inclusive; the thirteenth, such as have many stamina. Twelve, or half the Linnæan classes, therefore, are determined by the number of the stamina.

3. Eight, the 12th, 14th, 15th, 16th, 17th, 18th, 19th, and 20th, are determined by the comparative length of the stamina, and the manner in which they are inserted upon the receptacle.

4. Plants of the 21st have the male and female parts of fructification on the same plant, but in different flowers; those of the 22d on different plants; those of the 23d combine some of the peculiarities of the last two and of the preceding classes.

5. Besides the vegetables included in these 23 classes, there is a vast number of others, bearing, in common life, the names of Moss, Mushroom, and Sea-weed; whose mode of producing their seed is very obscure, and which were thrown by Linnæus into the single class Cryptogamia.

Orders. Each class is subdivided into orders, founded, through the first 13 classes, on the number of *the styles or female part of the flower;* in the 14th and 15th, on the fruit; in the 16th, 17th, 18th, 20th, 21st, and 22nd, on the number of the stamens; in the 19th, on the nature of the florets.

A Botanist does not, therefore, attempt to determine the name of a plant, unless he finds it in flower. In that case, if he employ the Linnæan method, he turns his attention first of all to the stamina, and determines the class; next to the parts on the diversities of which the orders are founded, and determines the order. He cannot proceed to the investigation of the genus and species till he is acquainted with the terminology of the science.

Terminology is a word derived from the Latin "terminus," meaning, first, a boundary, and secondly, a definition; because, to draw the lines by which a given idea is separated from every other, is to define it. The terminology of a science, therefore, is a collection of all the technical terms belonging to it, with their definitions. These terms relate to all parts of the plant,—the fruit, leaves, stem, and root; and, in the case of Botany, it is necessary that they should be numerous, by reason of the great number of objects, many of them bearing an intimate resemblance to each other, which we have occasion to describe and distinguish by our descriptions. One of the most important services rendered to the science by Linnæus, was that of giving copiousness and precision to the language it employs.

Genera. As the whole Vegetable kingdom is separated into classes, and each class into orders, so is each order subdivided into genera, and each genus into species.

The fructification was established by Linnæus as the only foundation of *generic* distinctions. Those plants which agree in this, are included under one genus; those which differ, are separated. It is to be remarked, however, that the agreement which determines the comprehension of different species, under the same genus, is not absolute. In making these divisions, the convenience of Botanists is consulted. Where a genus is very large and unwieldy, the separation of a part for the formation of a new one, will be warranted, though the differences in the fructification be such as would be neglected if the species it includes were less numerous. The particular difference on which the separation of a new genus is founded, is called its *essential character.*

Species. Specific differences take their rise from any constant circumstance, not liable to change by culture or other accidents, wherein plants disagree. Linnæus asserts the species to be as many as there were different forms of vegetables called into being at the Creation. Casual differences, produced by culture and other analogous causes, are called varieties.

A knowledge of the system of classification and terminology, prepares us for the study of nature by means of a Flora.

A Flora is a dictionary of plants, and is *general* when it contains the names of all known plants and their descriptions: *particular*, when it contains only those of a particular district. Thus, a Flora of Chapel Hill would contain the names of all the plants in our vicinity, arranged according to some method, and with their definitions annexed.

The use of a Flora is exactly the reverse of that of the common dictionary. Both contain all the words they propose to define, accompanied by a definition or description. But the object of the common dictionary is—the word being given to find the definition: with the Flora—a definition or description, or its equivalent, the plant itself, being given, to find the name.

The use of a system of classification is to enable us to refer with readiness to the part of the Flora where a description of a plant, of which we wish to know the name, is to be found. If we employ the Linnæan system, we attend, first of all, to the stamina, and determine the class; and, instead of having a whole volume or more before us, we know the description we are in search of will be found within a limited number of pages. We determine the order, and these undergo a further reduction—the genus; and we have then to look over but a moderate number of pages, even when the genus is the largest, to find the species or specific description, in connexion with which the name is always given.

If, however, we wish to become accurately acquainted with the plants of a district, we must form an Hortus-Siccus, or Herbarium. This is a collection of plants dried between sheets of bibulous paper. They exhibit the form, and frequently the colour, of the leaves and other parts. Its use is to enable us to compare species which do not flower at the same time of the year, or which we happen to meet with at times and places remote from each other; and thus obtain an accurate idea of the points of difference when there is a resemblance between them: also to review our studies at our pleasure.

Of Cryptogamous Plants.—The class Cryptogamia, into which Linnæus threw all the vegetables whose fructification is obscure, is larger than any other, and has furnished matter for several distinct sciences. Thus, the Filices or Ferns, the Musci or Mosses, both Hepatic and Frondose; the Fuci, Fungi, and Lichens; have been treated of in separate works. A man of liberal edu-

cation should be able to distinguish these several orders of the class Cryptogamia from each other, if nothing more.

In arranging these obscure and imperfect vegetable forms, we must adopt principles of classification different from those employed in the first 23 classes; though it is to the fructification that we still look for the distinctive characters of the orders and genera.

The Musci Frondosi, or proper Mosses, elaborate their seed in a cup or capsule, growing generally at the end of a stalk, and furnished with a lid; and beneath this with a row, and sometimes with two rows, of teeth, which were made by Hedwig the foundation of a new classification of the mosses. Hedwig, being also an accurate observer, and skilful delineator and describer of the mosses, acquired such a reputation amongst botanists, that he is seldom mentioned but with the epithet "immortal" attached to his name.

Acharius, a Swede, has given a new classification of the Lichens, and a description of many species in a thick quarto volume. Persoon, Schweinitz and others have made the Fungi or Mushrooms a particular object of their investigations. The Ferns, Liverworts, Confervæ, and Sea-weeds have had their economy and species amply described and illustrated.

Of the system of Jussieu.—The Linnæan system of classification, being founded on relations of number and magnitude, is more simple than any other, and better adapted to beginners; but determining every thing by the number and position of the stamina, it sometimes separates to a distance from each other plants which, in their habits and most striking characters, are very nearly related.

The whole Vegetable world falls naturally into several great families, the different members of which have an intimate resemblance to each other. Thus, amongst those that are cultivated in our gardens, the Cabbage, Turnip, Radish, Mustard, with some others resembling each other in their manner of growth, inflorescence, flavour of their leaves and fruit, constitute a natural family. The Parsnip, Carrot, Dill, Fennel, Celery, &c. constitute another. The Linnæan system *often* breaks up these natural families, and separates the members to a distance from those plants to which they are most nearly related.

It was to remedy this evil that Jussieu invented his system or method, in which the whole Vegetable kingdom was by him distributed into *one hundred families*, grouped together according to their natural affinities. By the laborers who have succeeded him in the same field, the number of these families has been more than doubled.

The Linnæan system is the most convenient for the beginner; that of Jussieu, by reason of its bringing into view the relationship of plants to each other, will become more of a favourite as our knowledge advances. The former is generally adopted in England, Germany, and the North of Europe; the latter prevails

in France, and is rapidly supplanting its rival in other countries.

It has been objected to Botanists, that they do not exert themselves enough to make their investigations and discoveries of advantage to mankind; that they are more anxious to add another to the thousands of worthless species already known, than to point out a new economical use of one with which they have long been familiar. The reproach does not seem to be merited. They are sufficiently anxious to show that the objects of their study may be useful to mankind, but an unyielding law of Nature for the most part denies them this satisfaction.

As part of a liberal education, the study of Botany is to be defended chiefly on the ground that it affords an excellent exercise to the mental powers, generates habits of accurate observation, and furnishes a source of elegant and innocent recreation and amusement.

ZOOLOGY.

The relative number of its species being considered, the Animal is found to be much richer and more diversified in its forms than the Vegetable kingdom. It becomes necessary, therefore, to separate it into a great number of tribes and families, by which its classification is rendered extremely complicated and difficult to be communicated, at least within the compass of a single lecture.

The abilities of Linnæus were great in every department of Natural History. Botany seems, however, to have been his favourite study; and it is as a Botanist that he will, through succeeding ages, challenge the admiration of mankind. Linnæus endeavoured to extend into the Animal those methods which he had so successfully introduced into the Vegetable kingdom; but though he could not employ his thoughts for a considerable time upon any subject, without leaving upon it the impress of his genius, it is now generally acknowledged that in Zoology succeeding observers may claim a decided superiority over the Swedish Naturalist. And amongst those who have laboured in this field of science, there is no one whose views have been so generally approved and adopted as those of CUVIER. It is then Cuvier's system of classification that is to be exhibited at this time.

Distinction between Animals and Vegetables. Before proceeding to the classification of animals, it is necessary that one question should be settled—*what is an animal, and how distinguished from a vegetable?* It seems, at first, to be extremely easy to draw a line of demarcation between the two kingdoms. An animal, we are prepared to say, is a living being, endowed with powers of sensation and locomotion: a vegetable, that which

has neither of these powers, but merely lives by drawing from the earth, by means of its roots, the juices that are necessary for its support. As a general account of what Animals and Vegetables are, and of the distinctions that obtain between the two kingdoms, these definitions answer very well. But the Sensitive Plant (and the same is true, though in a less degree, of some others) is strongly affected when touched, so as to receive a slight shock; the branches and leaves immediately collapse, and it is a considerable time before they recover their original position. The oyster and other shell fish, on the other hand, pass their whole lives on the spot where they were originally produced.

Between the higher and more perfect orders of animals and vegetables, there are strongly marked and very evident distinctions; but when we descend to the lower grades and more imperfect forms, they are seen to approach very near to each other. There is a difference in their chemical composition, and consequently in the elements they are disposed to separate from the matter around them, and associate as a part of their own constitution; and, with few exceptions, in the manner in which they receive their nourishment. Vegetables draw in the juices of the earth through their roots; animals have an interior sac or pouch, into which the nutritious matter on which they live is received, a portion separated and drawn off by the process of digestion, and the rest rejected. But even this does not apply to the sponge, heretofore regarded by most intelligent Naturalists as belonging to the Animal, though by Agassiz and Gould referred to the vegetable kingdom; nor to the lowest orders of Zoophytes, which present little more than an uniform pulp, endowed apparently with powers of sensation and motion.

The primary grand divisions of the Animal Kingdom are four in number, distinguished by the form and arrangement of the nervous system.

I. *The first division* comprises all such animals as have a brain and spinal marrow, with a hollow vertebral column provided as a receptacle for the spinal marrow, and a channel for conveying it through a considerable portion of the body. To this division, therefore, belong all Quadrupeds, Birds, Reptiles, and Fishes; in the skeleton and general economy of which, a considerable resemblance may be observed. They have all a muscular heart, red blood, and a system of vessels for its circulation, horizontal jaws, distinct organs of sight, hearing, tasting, and smelling. The sexes are always separate. To this division of the animal world, from the circumstance of their all possessing a vertebral column, the name of *vertebral animals* is given.

II. *The second division* comprises such animals as have no skeleton, and whose muscles are therefore attached to the skin, in which are formed, in many species, by a secretion provided for the purpose, stony plates called shells. The nervous system is composed of a number of distinct masses, scattered through the

body of the animal connected by small threads. The largest of these masses is seated on the throat, and is called the brain. The animals of this division have a complete system of vessels for carrying on the circulation, and distinct organs for respiration; the organs of digestion and secretion are almost as complicated as in the vertebral animals. Shell fish, through all their different varieties, are comprehended in this division, to which the name of *Mollusca* is given by Cuvier. It can be studied with advantage only by persons inhabiting the sea-shore.

III. *The third division* includes all the different varieties of insects, and is distinguished by a nervous system, consisting of two cords or filaments, ranging along the body, and swelling occasionally into a knot or ganglion; the largest of which, as in the preceding division, is on the throat, and is called the brain. The body is divided by a larger or smaller number of annular depressions, into distinct parts. The nutritive matter, taken in by the mouth, is imbibed directly by the rest of the body, instead of being circulated by means of the blood: proper lungs being altogether wanting, the respiration is carried on by means of spiracles distributed throughout the whole length of the body. The jaws are always lateral. There are organs of taste and sight; but, except in a single family, none of hearing. To this division the name of *Articulated or jointed animals* is given by the French; that of *Annulose*, by the English Naturalist.

IV. *The fourth division* comprehends the animals commonly known under the name of Zoophytes. The organs which, in the preceding divisions, were placed symmetrically on the two sides of an axis, are here arranged, for the most part, circularly around a centre. They have no very distinct nervous system, or organs of sense; and scarcely any of respiration. The only intestine is a cavity or bag, into which nutritive matter is received; a part absorbed by the body and the rest rejected. The Zoophytes evidently occupy the lowest place in the scale of animal being; some of the more imperfect genera presenting nothing more than a sort of uniform pulp, endowed with powers of motion and sensation. They are called *Radiated Animals* by Cuvier.

Of these four divisions of animals, it is evident that the first, or vertebral, is beyond comparison foremost in interest and importance; and that the third is next. It is to these that our attention will be very much confined at this time. The others are to be studied by professed Naturalists, the different species determined, and their forms, habits, and manners, accurately described; but by persons whose appropriate and peculiar business it is not to form an acquaintance with this part of the animal creation, they may be in a great measure neglected.

Classification of the Vertebral Animals. As the whole Animal kingdom was separated into four distinct sections, differing from each other in the form and constitution of their *nervous*

system; so the *respiratory* function is made, in its turn, a ground of division amongst vertebral animals; and, with reference to the diversities which it presents, they are arranged in four distinct tribes or classes:—Mammals, Birds, Reptiles, and Fishes. It is a distinguishing characteristic of the Mammalia, that they bring forth their young alive, and suckle them: hence the name they bear. But, as has been just stated, in our scientific systems, it is another particular that is looked to, especially for the characters, on which to found a distribution of the Mammalia into classes: and as man stands at the head of this division, it is in him that this particular may be most conveniently noticed. *Anatomical details respecting the provision that is made in the human frame for the circulation of the blood.* This fluid is distributed from the heart to the extremities of the body, through the arteries, and brought back by the veins: but before passing into the arteries a second time, it is exposed to the action of the air in the lungs.

Throughout the whole division of vertebral animals, the blood is exposed to the action of the air, or rather of one of the principles—the oxygen that is present in the air; but in each of the four classes into which they are divided in a different manner and degree, and connected with this diversity, there is a difference of external form, of habit, and manner of life. Though it be, therefore, a variety of structure in the organs of respiration that furnishes the characters by which the classes are distinguished, yet the classes thus determined are perfectly natural as well as distinct from each other.

1. The animals of the class *Mammalia* have all an organ similar to the human lungs, into which the blood passes after having been returned by the veins to the heart, and where it is exposed to the action of the air; *nor does this exposure take place any where else.* All animals in which this organization obtains, have warm blood; bring forth their young alive; and resemble each other in a great number of other particulars too numerous to be mentioned here.

2. The class of *Aves or Birds*, agrees with that of Mammalia, in requiring that the blood shall be exposed to the action of the air in the lungs before it passes into the arteries; but differs in that the covering of this organ is, in birds, pierced with large openings, which permit the air to enter many cavities existing in the breast, the body, and even in the interior of the bones. Throughout this whole extent of surface the aerial fluid applies itself to the blood-vessels, and acts upon their contents, so that the relative amount of *the influence exerted by the air upon the condition of the blood is much greater than in the Mammalia.* Lavoisier found that two swallows consume as much air as a Guinea Pig.

The living beings which possess this kind of respiration agree in their instruments of motion, which enable them to raise themselves above the surface of the earth, and journey in the light

and thin fluid which envelopes it; in the constant high temperature of their bodies; the energy of their muscular action, or the force which a muscle of a given volume is capable of exerting; and the mode of bringing forth their young—in the condition of an egg covered with a calcareous shell, in which the young bird is developed by a heat considerably above the medium temperature of the atmosphere, communicated, in most cases, by the mother. It is in part the quantity of their respiration that gives to birds a strength of voice so disproportioned to their size.

3. As the second class of vertebral animals is distinguished from the first by the possession of a *larger* respiration, so is the third separated by as wide a difference, but of *an opposite character*. The lungs do not in Reptiles constitute as large an organ as in the Mammalia; and provision is made for the passage of a *part* only of the blood through them, as in the course of its circulation it is returned to the heart; the rest passes on, and enters the artery without having been exposed to the action of the air. The change produced by respiration, and, of course, respiration itself, is therefore less necessary to this class than to either of the preceding.

Though differing considerably in their external forms, the animals included in it will be found to have many points of resemblance. Their blood has but a moderate degree of warmth; their power of muscular motion is not considerable; and if they sometimes move about rapidly for a short time, they are, nevertheless, disposed to pass their lives in inactivity; their brain is small, and has less influence over the nervous system than in the preceding classes; so that when the head is cut off, the rest of the body continues alive, and retains its power of voluntary motion for some time.

The heart does not immediately cease to beat when entirely separated from the body. The eggs of this class are never hatched, as in the preceding, by the incubation of the parent.

4. The only remaining class of vertebral animals is that which inhabits the water, and breathes that fluid instead of air. Fish have no lungs; but as it is necessary that their blood, too, should be subjected to the action of oxygen, *it is brought into connexion and contact with that element in what are called the gills.* The heart has but one auricle and one ventricle. When the ventricle contracts, the blood is sent out to all parts of the body. A portion of it enters the gills, and is there exposed to the action of air, dissolved in the water that is constantly flowing through them; after which it passes into a large artery, and so into the rest of the system. The quantity of his respiration being very small, it is evident that it must be insufficient to maintain the temperature of the fish much above that of the fluid in which he lives. He is therefore a cold-blooded animal; the quantity of his animation is much inferior to that of birds and quadrupeds; his capacity for muscular exertion is also less.

The dispute that has been carried on, much to the surprise and amusement of such persons as are altogether ignorant of Natural History—whether or not the whale be a fish? may be noticed here.

If we define a fish to be an animal of a certain shape, inhabiting the sea, and employing a forked finny tail as its principal instrument of motion, undoubtedly the whale is a fish; but if we say the fish is an animal, whose heart has but one ventricle, whose blood is cold, which respires water instead of air; the whale, certainly, is not a fish.

He respires air, and will as certainly die, and within a short time, if cut off from all communication with the atmosphere, as man himself. The large fin at the extremity of his tail is inserted with its plane in a horizontal instead of a vertical position, for the purpose of enabling him to rise suddenly and rapidly to the surface. His blood is warm; and it is to prevent the escape of the heat that has been generated in his body by the process of respiration when immersed in the cold waters of the Arctic seas, that he is furnished with that immense layer of oily matter for which he is pursued with so much eagerness by the seamen; and which is found, though of less thickness, in all hot-blooded animals inhabiting the water; in the dolphin or porpoise, for example, of our own bays and harbours. The whale brings forth its young alive, and suckles them, producing but one or two at a time instead of those millions and tens of millions that proceed from the roe of a single shad or herring. It is not wonderful, therefore, that in common parlance the whale should be called a fish, whilst in our accurate systems of Zoology he is classed with the Mammalia or land animals. "Swaggering parodoxes, if examined, sneak into pitiful logomachies."

Orders of the class Mammalia. As in his system of Botany Linnæus fixed upon a single part (the anthers) on which to found his scheme of classification, and his method was generally approved and adopted; so, when he came to introduce order and system into the Animal kingdom, he pursued the same course. In distributing the Mammalia into orders, he selected the *teeth* as the parts, which, by their *number*, *position*, and *form*, should furnish the necessary divisions. In general, this method answered tolerably well, separating the whole class into orders of convenient magnitude, and easily distinguishable from each other; whilst the animals associated, were found to have a considerable resemblance amongst themselves. But in a few instances, the classification of Linnæus was exceedingly faulty; animals being brought together, totally unlike in their size, form, and manner of life:—man, for example, and the bat. It has therefore been abandoned by Naturalists, and another founded, partly on differences in the extremities of the limbs, (the hands, feet, and claws,) and partly on the teeth; but which does not neglect other parts of the organization when they can be employed to advantage, in-

troduced in its stead. The extremities are first consulted, and the teeth and other parts afterwards employed as subsidiaries, affording in all nine orders: the Bimana, Quadrumana, Carnaria, Marsupialia, Rodentia, Edentata, Pachydermata, Ruminantia, and Cetacea.

The first order comprises the two-handed animals, of which there is but one species; Man, and several varieties. The second, the four-handed animals: as the Ourang-Outang, Ape, and Monkey; all of which have a form somewhat resembling that of man, a hand, a good deal like his; but differ in their lower extremity, which is also a hand, shewing that they were never intended by the Creator to maintain an erect posture, but to clamber amongst the branches of trees, and over the rocks, where they obtain their food. Four orders follow, resembling each other in the possession of paws, which they can employ in seizing their food and other objects, and which are therefore distinguished by their teeth or internal structure. The feet of the two next orders are useless, except as supporters of the body and instruments of progressive motion; the Ruminantia have the faculty of ruminating or chewing the cud. The Cetacea comprises such animals as approach, in their structure and economy, to the whale.

Orders of Birds. Linnæus divided the Birds into orders determined by the form of their *bills*. But here, as in the case of the Mammalia, by bringing in the feet to aid in the classification succeeding observers have improved upon the plans of this great Naturalist. Some of the orders are the same in both systems; that which comprehends the birds of prey, for example; whether we look to its talons, its hooked beak fitting it to tear the flesh from the bones of the animals it has killed, or observe its unconquerable spirit, prompting it to face the enemy and prepare for battle, however faint the prospect of victory, is possessed of characters too strongly marked to admit of its being confounded with any other.

Orders of Reptiles. The class of Reptiles naturally divides itself into four orders:—the Chelonia or Turtles, Sauria or Lizards (amongst which the Alligator is included), Ophidia or Serpents, and Batrachia or Toads, Frogs, &c.*

Orders of Fishes. In the Linnæan system, the class of Fishes is first divided into two smaller ones, one of which, the former, is subdivided into two orders, depending on the structure of the gills; and the latter into four, determined either by the total absence of the ventral fin, or its relative position with respect to the pectoral fin; whether before it, immediately under, or behind it. In this scheme Cuvier has made changes, but professes himself unsatisfied with his own arrangements.

Of the four classes of Vertebral animals, the second and fourth,

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* Χελωνη, a Tortoise; Σαυρα, a Lizard; Οφις, a Serpent; Βατραχος, a Frog.

birds and fishes, appear to possess the most interest as objects of study to an inhabitant of this country. Godman has given an excellent view of the Mammalia of North America in his Natural History; but this class is too limited in the number of its species, whether wild or domesticated, (not amounting to more than 80 or 90 within the limits of the United States, and not more than 20 or 30 at any particular locality,) to occupy us for any considerable time. We may find accounts of such as inhabit other countries in different books; but the work to which it was long customary to refer persons desirous of engaging in this kind of reading, was composed by a man who gravely wrote and published that the cow *sheds her horns* when three years old.

The class of Reptiles is made up altogether of such disgusting objects, that a person will hardly make them an object of study unless he has become a professional Naturalist, and laid in that store of enthusiasm which is necessary to carry him successfully through, whilst engaged with some other department of Natural History.

The Ornithology of the United States may be learned in the accurate and classical, though unpretending, volumes of Nuttall, or in those of Wilson, regarded as a splendid contribution from the Arts to the cause of science, until the work of Audubon threw all preceding publications of the kind into the shade. The objects of this science have much to commend them to our attention:—the beauty of their forms, the splendour of their plumage, and the sweetness of their song; whilst they inhabit our country in such numbers as to secure us from the danger of finding the subjects of study and investigation suddenly exhausted. Wilson's style is in a high degree lively and animated; and, by attributing to the subjects of his descriptions and histories the feelings and passions of men, and sometimes the art and finesse of intriguing politicians, (an embellishment whose value Naturalists are beginning to understand,) has succeeded in imparting to his work an interest it would not otherwise possess.

The Ichthyology of the American waters has never been very thoroughly explored, and has therefore one thing at least in its favour;—that it presents a wide field for investigation and discovery.

Leaving the Vertebral Animals, we pass to the second division of the Animal kingdom, comprehending the races which Cuvier, giving an extension to the meaning of the word which does not belong to it in the writings of Linnæus, has arranged under the general name of Mollusca. In this division the science of Conchology is included as part of a greater whole. From its connexion with the science of Geology, as well as on its own account, Conchology will always possess a high degree of interest, especially for the men of science who inhabit that vast repository of antediluvian remains—the Low Country of the United States; but for acquiring a knowledge of the system of classification

adopted in this department of Natural History, a good collection of shells, and more time than we can devote to the subject, are absolutely necessary.

Classification of Insects. The third division of Animals, embracing the almost innumerable races and tribes of insects, presents a field where the most active and industrious mind may expatiate throughout the whole extent of the longest life. Linnæus distributed it into seven orders, determined by the number and forms of their wings.

1. The first, or *Coleoptera* order (from κολεος a sheath, and πτερον a wing,) has double wings, of which the exterior are merely a hard horny covering, uniting along the back of the insect, and serving, as the name imports, for a sheath for the thin gauze-like wing that lies below, and which alone is of any use in flying. To this order belong all the various tribes of beetles.

2. The second, or *Hemiptera* order (from ἡμισυ half, and πτερον,) have their upper wings partly crustaceous and partly membranaceous ; and, instead of being united along the back, incumbent upon each other, as in the Grasshopper.

3. The *Lepidoptera*, (from λεπις a scale,) have four wings covered with fine scales, as in the Butterfly.

4. The *Neuroptera*, (from νευρον a nerve,) have four membranaceous, transparent, naked wings, reticulated with veins or nerves ; the tail being without a sting, as in the Musquito-Hawk.

5. The *Hymenoptera*, (from υμην a membrane,) have membranaceous wings, and a sting in the tail as in the Wasp.—

6. The *Diptera*, (from δις twice or double,) have only two wings and poisers as in the common house-fly. The *Aptera* are without wings.

The Linnæan system of Entomology, like other classifications of his, has been reviewed and corrected by later Naturalists. Great changes have been made, especially in the last order, Aptera ; and the whole race of crabs, craw-fish, and spiders, separated from it, as not being proper insects, and formed into a separate and distinct class by themselves. The forms of the mandibles or jaws, and of the feet, have also been brought in to aid in cases where the characters drawn from the wings were unsatisfactory.

A question may arise, whether the science of Entomology is worthy of attention at all, it having been sometimes condemned and rejected as altogether frivolous and trifling, and beneath the attention of intellectual man? To these objections it may be replied, that what it comported with the dignity of the Wise and Glorious Author of Nature to create, it is not beneath the dignity of man to study. The science of Entomology is, undoubtedly, not entitled to a very high rank amongst the objects of human knowledge ; but we are perhaps as rationally and usefully engaged, when tracing the indications of Divine ingenuity and wisdom, displayed in these diminutive forms, as

when occupied with the common employments of mankind,—the eager pursuit of wealth, the intrigues of ambition, or the heartless interchange of civilities that constitute what is called fashionable life. To men of wealth and leisure, to all who have no constant and engrossing employment, this science offers an inexhaustible fund of harmless amusement; and, in a few instances at least, the researches of Entomologists have brought facts to light that are useful as well as entertaining. The discoveries that have been made in modern times, in relation to the habits and manner of life of the genus Œstrus, may be cited as an example.

It is known to such persons as have a moderate acquaintance with rural economy, that a grub infests the stomach of the horse, which sometimes penetrates its coat, and produces an inflammation that is fatal: that the backs of cattle are attacked by another grub, commonly called the wolf, who takes up his dwelling just beneath the skin, and produces a foul ulcer, which must evidently have a pernicious effect upon the general health of the animal. There is another who establishes himself high up in the nostrils of the sheep, and nearly between the eyes; the hare and deer are assaulted by other parasites of the same kind.

All these pests are species of the same genus, Œstrus, and in their perfect state are insects something like the bee. The Œstrus Equi may be seen buzzing about a horse, and depositing its eggs in the latter part of summer. Perfect winged insects pass through four different states or forms of existence. They come into being in the condition of eggs; when hatched, they are small maggots or worms; a third form is then assumed, under which they are generally torpid and inactive, and from which they emerge perfect winged insects or flies.

It has been ascertained that the different species of the genus Œstrus are formed to pass the second stage of their existence within the body of some animal; one in the stomach of the horse, a second in the back of the ox, &c. The horse grub, then, is the larva of an insect. The parent fly very industriously deposits her eggs upon the hair of the horse; the animal, in endeavouring to rid himself of the various enemies and tormentors by whom he is harassed, gets them upon his tongue, where they are immediately hatched; and, passing into the stomach, affix themselves, by means of hooks with which they are provided for the purpose, to its sides. Here they sometimes remain until the time arrives for their second change, and then pass away without producing any essential injury; in other cases, the life of the horse is destroyed. The Œstrus of the ox provides a dwelling place for her young, by piercing the skin and depositing her egg; which, after being hatched, lives for nearly a year in the body of the animal. It is evident that when these facts are well ascertained, it is in our power to pre-

vent horses from being infested with the grub at all, by removing the eggs of the Œstrus as fast as they are deposited.

The number of instances is not great where we derive any direct and positive advantage from insects. There are a few—as the silk-worm and bee, the Coccus Cacti or Cochineal insect, which furnishes the most precious of all our dyeing drugs; the only one, in fact, with which we can produce a bright crimson or scarlet:—the Cantharis Vesicatoria, or blistering fly of Latreille, an important and valuable article of the Materia Medica, and a few others.

The cases are more numerous where the insect tribes, instead of friends prepared to minister to our wants, present themselves in the character of terrible enemies. We pass over those which infest our persons, such as the gnat, mosquito, chinch, tick, redbug, &c.; remarking only that the general name which these little creatures bear, is a sufficient proof of the horror in which they are held, and of the high idea entertained by mankind of the extent of their power to do evil. The word Bug, in the Old English, meant an evil spirit or demon. Thus, in an ancient translation of the Bible, the passage where it is said of the good man, that "He shall not fear the terror or evil spirit by night, nor the arrow that flieth by day," reads, "Thou shalt not neede to be afraide of any Beugges by nighte, nor of the arrowe that flieth by daye." We omit also those which, in the condition whether of larvæ or of perfect insects, carry on their depredations in the gardens, cultivated fields, and forests of our own country, and notice only a single scourge of the Eastern continent.

The Arabians make a locust say to Mahomet, "We are the army of the Great God; we produce ninety-nine eggs; if the hundred were completed, we should consume the whole earth and all there is in it." The locust mentioned in the Scriptures, and in other writings relating to the countries about the Mediterranean, is a different insect from that bearing this name in the United States, belonging to the same genus with the common grasshopper. He has, of course, the same general form, but is larger; and both in his power of re-production and the undecaying vigour of his appetite, is still more decidedly superior.

Locusts sometimes unite and emigrate in immense legions, converting every country over which they pass into a desert. In their passage through the air they resemble a thick and heavy cloud; the whole surface of the ground is covered by them when they alight; and its whole produce, whether of herb or tree, devoured; so that not the least vestige of green is left behind. The empire of Morocco was wasted by them from 1778 to 1780; and so severe a famine ensued, that vast numbers of persons perished; the roads and streets exhibited the unburied carcases of the dead; fathers sold their children, and husbands their wives. They were at length carried by a violent storm into

the Western Ocean; and their dead bodies cast upon the shore, created a stench that produced a pestilence. Barrow states, that when a similar army was drowned off the coast of South Africa, the smell of their decaying carcases was distinctly perceived with a favourable wind at a distance of one hundred and fifty miles. With such myriads of enemies, insignificant though they may be individually, it is vain to contend in open battle; but with a thorough knowledge of their economy, in the four different conditions of their existence, the intelligence of man may enable him to elude their attacks.

The remaining division of the Animal kingdom (Zoophytes) is imperfectly understood by the most accomplished Naturalists.

MINERALOGY.

Minerals are those bodies destitute of organization, which exist naturally, either within the earth or at its surface. Their different kinds or species it is the object of the science of Mineralogy to ascertain, classify, and describe.

In this definition, the words "*destitute of organization*" are necessary to distinguish them from plants and animals: the words "*exist naturally*," to distinguish them from a brick or statue that lies buried in the ground; and "*within the earth or at its surface*," that we may have a line of separation between them and the heavenly bodies.

The Germans, by whom this science has been cultivated with more zeal and success than by any other people, have sometimes employed to denote it the word Oryctognosy, from the Greek ορυκτος and γνωσις,—the science of things that are dug up; but as this, according to its derivation, would include fossil organic remains, it is less precise and definite than the word Mineralogy. They have also separated it into a number of branches or subordinate sciences; as Descriptive Mineralogy, the science of describing; Determinative, that of determining minerals: Geographical, Economical, and Chemical Mineralogy, the sciences which make known their geographical distribution over the surface of the globe, their uses in the Arts, and Chemical constitution. There seems to be no necessity for all these divisions, though no one of the particulars to which they refer is to be neglected.

Minerals are divided into two great classes:—

1. *Simple minerals;* which have all their *integrant* particles alike. Examples: Quartz, Carbonate of Lime.

2. *Compound minerals;* which contain two or more kinds of *integrant* particles: Example, Granite, which contains three.

If a simple mineral be broken into fragments, the pieces and particles will be substantially alike, except in size and shape; but if a compound mineral be broken, some of its parts will be unlike

each other. Simple minerals belong to the science of Mineralogy; compound ones, to that of Geology; which latter science also proposes to itself, as one of its objects, to account for the production of all minerals in the places and under the circumstances in which we find them. A knowledge of Mineralogy prepares us for the study of Geology.

By reason of the smallness of the number of the mineral species, which, including every obscure variety, probably does not exceed one thousand, classification is by no means as important in this Science as in Botany and Zoology. All the species may be described in a volume of moderate size, and an individual looked out without any great difficulty, even though the book should make no pretensions to a regular arrangement. Nor, supposing the best possible scheme of classification adopted, will it afford us the *same kind and amount* of assistance that we derive from the same source in the Animal and Vegetable kingdoms; enabling us to determine with precision and certainty, first, the class of a mineral; next, its order; and then the genus and species. The system of Mohs, which ranks first in its claims and pretensions, falls immeasurably behind those of Linnæus, Jussieu, and Cuvier, in regard to the aid afforded by it in the discrimination of species; and where it is an uncrystallized mass of a substance that is under examination, (by far the most common case,) its advantages disappear altogether. Classification is not to be neglected in the Mineral kingdom; but its usefulness will be felt in the convenient arrangement it enables us to give to knowledge already acquired, rather than in the increased facilities it affords in the acquisition of knowledge.

The means we possess of distinguishing minerals from each other, are much more limited than those we can employ in the case of plants and animals. These have a particular range of country and climate to which they are confined, some inhabiting the mountains, and others the plains; some the high latitudes, and others the torrid zone. But, especially, each species has a *particular form*, which the principle of life to which it owes its development has impressed upon it, and which is not subject to vary. The same mineral, on the other hand, occurs on the tops of the highest mountains, and in the beds of the streams that flow around their bases, in every latitude; and, in many cases, under every variety of form.

Minerals are distinguished from each other by their properties, commonly called characters; which may be distributed into two great classes, and these into five small ones.

First, the *Physical or external;* and secondly, the *Chemical Characters.*

The Physical or external characters are of three kinds:—

1. Those which are furnished by uncrystallized and irregular masses of the mineral, as well as by the crystalline forms.

2. Those which are furnished by minerals only when in a state of crystallization.

3. Such as are derived from the circumstances under which the mineral is found in its native bed; the kind of rock in which it lies.

The Chemical characters are of two kinds:

1. Those which are obtained from an accurate analysis of the mineral.

2. Those which are obtained by subjecting it to the action of certain chemical agents, such as heat, either with or without the aid of fluxes, acids, &c., without instituting a regular chemical analysis. The first and last of these subordinate classes are much the most important to the common practical student of Mineralogy.

Of the characters which are furnished by uncrystallized and irregular masses of minerals, as well as by the crystalline forms, 20 are enumerated by Phillips, who proposes to give a complete catalogue:

1. Structure.
2. Fracture.
3. Frangibility.
4. Hardness.
5. Transparency.
6. Lustre.
7. Colour.
8. Flexibility.
9. Elasticity.
10. Touch.
11. Taste.
12. Odour.
13. Streak.
14. Powder.
15. Adhesion to the tongue.
16. Magnetism.
17. Electricity.
18. Phosphorescence.
19. Specific Gravity.
20. External Form.

1. The *structure* depends upon the shape, size, and arrangement of the minute parts of the mineral. It is exhibited when the mineral is broken, and presents a number of varieties, as

1. *Fibrous;* when the mineral is made up of fibres lying by the side of each other.

2. *Foliated or Lamellar;* when it is constituted of plates or laminæ.

3. *Slaty;* when the laminæ are larger and less distinct.

4. *Radiated;* when it presents the appearance of rays diverging from a centre.

5. *Granular;* when it is made up of distinct grains.

6. *Compact;* when the whole is a dense homogeneous mass.

2. The *Fracture;* is the form of the surface which compact minerals, especially, present when broken. It exhibits the following varieties:

1. *Even;* which has few or no inequalities.

2. *Uneven;* when the surface is rugged and irregular.

3. *Conchoidal;* presents convex elevations and concave depressions, resembling the contour of a shell. It is more or less perfect, large, small, deep, and flat.

4. *Splintery;* exhibits small portions of the mineral, adhering like scales to the part that remains solid and unbroken; the adhesion being by the thicker part of the scale, whilst the thinner is free. Its varieties are those of coarse and fine.

5. *Earthy;* may be seen in a piece of clay or chalk. The particles of the mineral appear to be loosely aggregated.

6. *Hackly*, belongs almost exclusively to the metals. It is seen in the fresh fracture of a piece of steel.

3. *Frangibility* is that property of minerals by which they separate into fragments when struck with a hammer. The only modification of which it appears to be susceptible, is in the degree. Thus, we say a mineral is very tough, tough, moderately tough; brittle, very brittle: some of the hardest substances are very brittle.

4. "*Hardness*, which is found in different bodies in different degrees, consists in a firm cohesion of their component particles; and that body is said to be harder than another whose particles require a greater force to separate them." It is a character of such importance, that an attempt has been made to found a system of classification upon it. It may be ascertained in two ways:

I. By a comparison of minerals with each other. Thus, of the following: Diamond, Corundum, Topaz, Quartz, Feldspar, Apatite, Fluor-spar, Calcareous-spar, Gypsum, Talc, Elastic-Bitumen; the first scratches the second, the second the third, &c.

II. By comparing them with well tempered steel, when we have the following distinctions:

1. *Extremely hard*, when it receives no impression from a file, as Sapphire.

2. *Very hard*, when a file produces but little effect, as Garnet.

3. *Hard*, when it is very little affected by the knife, but yields without difficulty to the file, and gives fire with steel, as Feldspar.

4. *Semi-hard*, when it yields without much difficulty to the knife, but does not give fire with steel, as Fluate of Lime.

5. *Soft*, when it is easily cut by a knife, but receives no impression from the finger nail, as Carbonate of Lime.

6. *Very soft*, when it may be impressed by the finger nail, as Sulphate of Lime.

The circumstance of a body's giving fire in greater or less abundance with steel, is not a good criterion of its hardness.

5. *Transparency* is not an important diagnostic character of minerals, because the number of those which transmit light is not great, and the degree in which it is transmitted varies very much, even in different parts of the same specimen. A mineral is said to be,

1. *Transparent*, when objects can be distinctly seen through it.

2. *Semi-transparent*, if we can perceive an object behind the mineral, but without being able to distinguish more than its general outline.

3. *Translucent*, if a small quantity of light only passes through the mineral, but without allowing an object behind it to be seen, except in so far as it in general may prevent the light from falling upon the mineral.

4. *Translucent on the edges*, if only the most acute edges of the mineral transmit some light, whilst the rest of it remains dark.

5. *Opaque*, when it transmits no light at all.

6. *Lustre* is a character of some importance in the discrimination of minerals. It admits of a number of different varieties; as,

1. The Metallic Lustre, or lustre of polished metals.

2. The Adamantine Lustre exhibited by the diamond.

3. The pearly lustre, silky lustre, resinous lustre, vitreous lustre, waxy lustre, and some others, which need no explanation. When a mineral is destitute of lustre, it is said to be dull.

7. *Colour* is a striking, but by no means an important, character of minerals; there being but a few in which it is invariable. It is produced by a small quantity of some metallic oxide, commonly iron or manganese, which is present to such an amount as to determine the hue, without causing any alteration in the general range of the characters of the mineral. A change in the degree of oxidation will produce a change in the colour.

8. *Flexibility* is a property of a few minerals, which, when bent, do not resume their former shape. Talc is flexible.

9. *Elasticity* is a property of a few minerals which may be bent, but when the force applied to them is removed, recover their former figure. Thus, Mica is elastic.

10. *Touch* is a diagnostic character of some importance. Most minerals have a dry harsh feel. A few only, into whose composition magnesia enters largely, are unctuous to the touch, as Soap-stone.

11. *Taste.* The only minerals that can be distinguished by their taste, are a few soluble salts. Most earthy minerals have no taste, and but little difference can be observed amongst those that possess it.

12. *Odour.* When rubbed together or breathed upon, certain minerals give out a peculiar odour. Thus, some into whose composition alumina enters largely, have an argillaceous smell when breathed on.

13 & 14. *The Streak* is the colour which a mineral exhibits when scratched, and is the same that is produced by reducing it to a fine powder in a mortar. It sometimes differs very much from that of the mineral *en masse*.

15. *Adhesion to the tongue* depends upon the disposition of the mineral to attract moisture. It is strongest in argillaceous substances, but observed also in some specimens of chalcedony and flint.

16. *Magnetism*, or the property of being attracted by the magnet, belongs to but three of the metals, and not to these when they are largely combined with oxygen, sulphur, or other mineralizing substances. It is strongest in the ores of iron.

17 & 18. *Electricity and Phosphorescence* are curious and remarkable properties of minerals, but do not afford much assistance in the discrimination of species.

19. *Specific Gravity* is an important character. The principles and processes that are applied and employed in ascertaining it, belong to Mechanical Philosophy. In stating it, reference is always had to pure water as a standard.

20. *External Form.* This becomes an object of consideration in minerals, chiefly when they occur in the condition of crystals; but uncrystallized specimens of chalcedony, prehnite, and iron ore, frequently present a surface that is stalactitic, mammillary, botryoidal, &c.; which forms, therefore, are characteristic of those substances.

Second subordinate class of characters.—"Those which are furnished by minerals only when in a state of crystallization."

Crystals occur in nature imbedded in the rocks, and especially in the veins from which the metallic ores are extracted. When large and beautiful, they are carefully preserved, and find their way, at length, into the cabinet of the Mineralogist, of which they form a much larger part than of the rocky strata, from which they were originally derived. In determining the arrangement of a cabinet, or the whole number of species existing in the Mineral kingdom, they are of very great value; but as they are of rare occurrence, the assistance they are likely to afford to the young amateur in mineralogy is not very considerable. A crystal may be employed in four different ways:

1. It may be dissected, and the primitive form, or nucleus, obtained, and used in the determination of the species.

2. It may be dissected, and the integrant molecule obtained and employed in the same way.

3. Its angles may be measured with the Goniometer. Account of the common and reflective goniometer.

4. The effect produced upon a beam of light that passes through it may be observed.

Third subordinate class of characters.—"Such as are derived from the circumstances under which the mineral is found in its native bed; the kind of rock in which it lies."

Geologists divide the rocks into four classes: the Crystalline or Primitive, Transition, Secondary, and Tertiary or Alluvial. Certain minerals are always found associated with, or imbedded in, one of these classes of rocks, whilst it is altogether in vain to look for them in the others.

Fourth subordinate class of characters.—"Those which are obtained from an accurate analysis of the mineral."

Some Mineralogists reject the chemical characters altogether, and will not allow them to be used in the determination of minerals. Thus Mohs will not allow that any property or character may be employed, which becomes manifest only during, or after, some change produced in the condition of the mineral, *because the use of them is not agreeable to the principles of Natural History.* But it seems like the foppery and pedantry of science to labour for a day to determine a mineral by its natural

historical characters, and remain uncertain about it, after all; when, by letting fall a drop of acid, or directing the flame of a blow-pipe for a moment upon it, we decide the matter at once. Did minerals always present themselves in the condition of perfect crystals, so as to enable us to proceed with precision and certainty according to the natural historical method, this claim for the exclusion of chemical processes from the science of Mineralogy might more easily be sustained.

Chemical analysis, by ascertaining the composition of minerals, determines their identity or specific difference; but as it requires time, chemical apparatus, and a familiarity with the processes of the laboratory, it will commonly be resorted to in those cases only where the masters of the science are in doubt or at variance in regard to a mineral.

Fifth subordinate class of characters.—"Those which are obtained by subjecting the mineral to the action of certain chemical agents, such as acids, and heat, either with or without the aid of fluxes, without instituting a regular chemical analysis."

The acids are employed, chiefly, for detecting the presence of carbonic acid, and especially of the compound formed by the union of this acid with lime, carbonate of lime, or common limestone. Either of the strong acids (the Nitric, Sulphuric, or Muriatic) may be used. A nitrate, sulphate, or muriate is formed, and the carbonic acid escaping in the gaseous state, produces an effervescence commonly visible to the eye, but most easily detected by the ear. A small fragment may be put into a watch-glass, and the acid, diluted with water, poured on, or a glass stopper, moistened with the acid, may be applied to the surface of the mineral. The muriatic or hydrochloric acid, as being less corrosive, is commonly preferred.

Heat is applied by means of the blow-pipe, which, in its simplest form, is a slender, hollow, conical tube; bent at a right angle near its smaller extremity, and used for directing a current of air from the mouth through the flame of a lamp or candle. Two flames (an exterior yellow and an interior blue) are produced. The heat at the extremity of the blue flame is very intense. The fragment of the mineral operated upon should never be larger than a peppercorn, and it is best to have it very much smaller. It is to be supported on charcoal, platinum foil, or in the angle of a bent platinum wire. The lightest charcoal is the best, and being itself combustible, and a bad conductor of heat, there is formed, at the point on which the flame falls, a little furnace of great power. Platinum is, in comparison with other metals, a bad conductor; and undergoing no change, at the temperature generated by the blow-pipe, admits of a peculiar neatness in the experiments where it is employed. By varying the circumstances under which the flame of the blow-pipe is applied, a variety of effect may be obtained. Where fusion is

produced, the resulting body exhibits a considerable diversity of appearance, requiring the following definitions:

A *slag* is an opaque semivitreous mass, containing metallic matter.

A *scoria* is a light spongy mass of the same kind.

An *enamel* is an opaque substance, reflecting light as glass does, from its external surface.

A *frit* is a vitreous mass, having infusible opaque particles disseminated through it.

Some minerals, when fused either alone or along with other substances, yield a perfect glass, which is, however, seldom destitute of colour.

Bodies, which will not melt by themselves, often become fusible by the addition of something else, of which quartz, whether under the form of rock-crystal, common white flint, or siliceous sand, is an example. Along with potassa or soda, it is fused without difficulty, forming glass. The material added to communicate fusibility is called a flux. That most commonly employed is the biborate of soda or Borax, which, by the variety of hues it exhibits with the different metallic oxides, furnishes an additional diagnostic character. Soda, the Phosphate of Soda, and Ammonia, called also Microcosmic Salt, and some others, are used.

Classification of Minerals. It is desirable to arrange the objects of our study in such order as shall either facilitate the formation of an acquaintance with them at first, or enable us to recollect their composition and properties afterwards. For the latter object, a classification, founded on their chemical constitution, seems preferable to every other.

All the simple bodies must necessarily enter into the composition of some mineral. They combine with each other, forming the first order of compounds, which, uniting again in various ways, produce the different substances by which we are surrounded. The most important of them all is oxygen, which, if the interior resembles the exterior crust of the globe, constitutes nearly one half of the earth. It combines with all the rest, generally in a number of different proportions; but a part only of the compounds thus formed enter into the composition, and constitute the proximate elements of minerals. They are found to arrange themselves into two distinct classes:

1. *The Acids*, of which, including silica, about twelve are found entering into the composition of minerals.

2. *The Oxides*, comprehending all the rest.

These two classes have a disposition to combine; an acid with an oxide, and form a class of substances called salts, which are the principal objects of the science of Mineralogy, though some simple substances, and many *binary* compounds of oxygen, and the other elements, of sulphur and the metals, &c., are interesting and important minerals.

The Oxides are subdivided into three smaller classes:

1. *The Earths.* Lime, Baryta, Strontia, Alumina, Magnesia, Glucina, Zirdonia, Yttria, Thorina, and Silica; which, though an acid, is commonly ranged with the earths—ten in number.

2. *The fixed Alkalis.* Potassa, Soda, and Lithia—three in number.

3. The proper metallic oxides.

These distinctions are the foundation of a distribution of minerals first proposed by Avicenna into four classes.

1. *Earthy Minerals*, comprising such as are made up of the seven Earths,—Silica, Lime, Alumina, Magnesia, Glucina, Yttria, and Thorina; and the three Alkalis, without any other acid than Silica.

2. Acidiferous Minerals, including all that contain an acid, the metallic ores excepted.

3. Combustibles, made up chiefly of carbon and hydrogen.

4. The proper Metallic Ores.

We shall treat of Minerals in this order. The earthy minerals are subdivided into such as do and do not contain an alkali; and the acidiferous, into those in which the acid is united to an earth and an alkali.

The earthy minerals make up nearly seven-eighths of the globe, constituting the mountain masses, amongst the rents, fissures, and veins of which the others lie imbedded; and with great propriety, therefore, they occupy the first place. The acidiferous minerals are next in abundance, especially the salts of Lime, and have the second place. Whether the combustibles or the metallic ores shall come next, is a matter of little importance.

The constituents of the *earthy minerals* are abundant in the following order: Silica, Alumina, Magnesia, &c. We treat, therefore,

1. Of the minerals made up principally of *Silica*, or which derive their peculiar properties from the presence of that earth.

2. Of those made up of, or deriving their properties from, *Alumina*.

3. Of the Magnesian Minerals.

4. Of the rest, which, being few in number, may be treated of in almost any order.

Distinction between the different kinds of Rocks. Geologists divide the rocks into four principal classes.

1. *Primitive Rocks.* These have a crystalline structure, and are older than the following classes, as is proved by the fact that the others rest upon, and have therefore been deposited upon, them. They are not covered by the others *in all places*, but pierce through them, and form the summits of the loftiest mountains. Most of the western counties of North Carolina are primitive; so is a great part of Wake, Nash, Franklin, Warren, and Granville, though partially covered by the sand.

2. *Transition Rocks.* They are made up, at least in part, of the rounded and angular fragments of older rocks, which have been brought together and consolidated; but they contain few organic remains, from which it is inferred that they were formed before the existence of the more perfect animals. The rocks in the central parts of North Carolina, Person, Orange, Randolph, Montgomery, Anson, &c., belong to the transition class.

3. *Secondary Rocks.* These are such as contain Organic Remains, and especially the exuviæ of shell fish, in great abundance; so as frequently to be made up almost exclusively of them. They abound in the States of Ohio, Kentucky, and Tennessee. They exist about Wilmington, and in other parts of the Low Country of North Carolina; but are mostly covered by the sand.

4. *Tertiary Strata,* including Alluvial ground. They are often not sufficiently consolidated to be entitled to the name of Rock, and are more recent than the secondary. The Low Country of the United States is commonly referred to this class.

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